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OBLON, SPIVAK, MCCLELLAND MAIER & NEUSTADT, L.L.P. 1940 DUKE STREET ALEXANDRIA, VA 22314				
EXAMINER				
PARENDO, KEVIN A				
ART UNIT		PAPER NUMBER		
2823				
NOTIFICATION DATE		DELIVERY MODE		
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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

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Office Action Summary

Application No.

10/567,733

Applicant(s)

KAWAMURA ET AL.

Examiner

Kevin Parendo

Art Unit

2823

Period for Reply -- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 08 October 2009.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-19 is/are pending in the application.
- 4a) Of the above claim(s) 13, 16 and 17 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-12, 14, 15, 18 and 19 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO/SB-06)
Paper No(s)/Mail Date 8/11/09
- 4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date _____
- 5) ☐ Notice of Informal Patent Application
- 6) ☐ Other: _____

DETAILED ACTION

Claim Rejections - 35 USC § 112

The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

1. Claim 3 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claim 3 recites the limitation "said modifying step is conducted in radicals containing any of N, Ar, Kr, C, B and Si" on line 2. The metes and bounds of the claimed limitation can not be determined for the following reasons: Claim 1 requires "modifying said F-doped carbon film by nitrogen radicals". Thus, it is unclear if nitrogen is required in the method of claim 3, or if it can indeed be any of N, Ar, K, C, B, and Si.

In light of the aforementioned rejections of the claim(s) under 35 U.S.C. 112, the subsequent rejections under 35 U.S.C. 102 and/or 103 are based on prior art that reads on the interpretation of the claim language of the instant application as best understood by the examiner.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

2. Claims 1-4, 6, 10-11, and 18-19 are rejected under 35 U.S.C. 102(e) as being anticipated by US 6,764,939 B1 ("Yoshitaka").

Re claim 1, Yoshitaka discloses a film forming method, comprising the steps of:

- forming a F-doped carbon film **206** (column 3, line 36 and column 6, line 15) by using a source gas containing C and F (C_4F_6 , column 6, line 18);
and
- modifying (etching, see column 9, lines 17-23) said F-doped carbon film by nitrogen radicals (column 9, line 19, wherein nitrogen is in the plasma; and column 9, lines 45-47, wherein radicals are said to be produced as etching active-species by producing plasmas),
- wherein said source gas has a F/C ratio larger than 1 and smaller than 2 (C_4F_6 , column 6, line 18), the F/C ratio being defined as a ratio of a number of F atoms to a number of C atoms in a source gas molecule.

Re claim 2, Yoshitaka further discloses that said modifying step is conducted so as to remove F atoms (the whole film is etched, including F atoms that terminate the exposed surface, see holes **206A** formed in Fig. 2B and hole **212A** formed in Fig. 2E) terminating an exposed surface of said F-doped carbon film.

Re claim 3, Yoshitaka further discloses that said modifying step is conducted in radicals containing any of N, Ar, (nitrogen and argon, see column 9, line 19) Kr, C, B and Si.

Re claim 4, Yoshitaka further discloses that said radicals are excited by a microwave plasma (column 5, lines 4-6, column 1, lines 41-42).

Re claim 6, Yoshitaka further discloses that said source gas includes any of C_3F_4 , C_4F_6 and C_5F_8 (C_4F_6 , column 6, line 18).

Re claim 10, Yoshitaka discloses a method of fabricating a semiconductor device, comprising the steps of:

- depositing a F-doped carbon film **206** (column 3, line 36 and column 6, line 15, and Fig. 2A) on a substrate (column 3, line 39) by a plasma CVD process that uses a source gas (C_4F_6 , column 6, line 18) that contains C and F in a molecule thereof;
- forming an opening **107A** (Fig. 2F) in said F-doped carbon film by a dry etching process (column 7, lines 14-15) of said F-doped carbon film; and
- covering a sidewall surface and a bottom surface of said opening by a metal film **207a** (column 7, line 22 and Fig. 2G),
- wherein there is provided, after said step of forming said opening but before said step of covering said sidewall surface and bottom surface of said opening by said metal film, a step of modifying (etching, see column 9, lines 17-23) at least said sidewall surface of said opening by nitrogen radicals (column 9, line 19, wherein nitrogen is in the plasma; and column

9, lines 45-47, wherein radicals are said to be produced as etching active-species by producing plasmas), said source gas having a F/C ratio larger than 1 and smaller than 2 (C₄F₆, column 6, line 18), the F/C ratio being defined as a ratio of a number of F atoms to a number of C atoms in said source gas molecule.

Re claim 11, Yoshitaka further discloses that said radicals in said modifying step are excited by a microwave plasma (column 5, lines 4-6, column 1, lines 41-42).

Re claim 18, Yoshitaka further discloses that said nitrogen radicals are formed from a mixed gas of Ar and nitrogen (nitrogen and argon, see column 9, line 19).

Re claim 19, Yoshitaka further discloses that said nitrogen radicals are formed from a mixed gas of Ar and nitrogen (nitrogen and argon, see column 9, line 19).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

The examination guidelines for determining obviousness under 35 U.S.C. 103 are described in MPEP 2141-2145.

The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

3. Claims 1, 3, 6, 7, 8 and 18 are rejected under 35 U.S.C. 103(a) as being unpatentable over US 2004/0161946 A1 ("Tsai") in view of US 2003/0025209 A1 ("Jiwari").

Re claim 1: Tsai discloses a film forming method, comprising the steps of:

- forming a F-doped carbon film (step 201 of Fig. 2; paragraph 14) by using a source gas containing C and F (paragraphs 15 and 38); and
- modifying said F-doped carbon film by nitrogen radicals (the plasma may also contain nitrogen, see paragraph 38; it is well known that plasmas create ions and radicals of their constituent gases; see for example paragraph 47 of Jiwari),
- wherein said source gas has a F/C ratio larger than 1 and smaller than 2 (specifically, discussed to be "less than 2", see paragraph 15; in no instance is it discussed to be less than 1, and specified examples used are between 1 and 2, see paragraph 38), the F/C ratio being defined as a ratio of a number of F atoms to a number of C atoms in a source gas molecule.

The nitrogen radicals being used during the formation of the film can be reasonably interpreted as "modifying the film by nitrogen radicals", as discussed above. However, Jiwari discloses that the a first fluorine-containing organic film (paragraph 10)

that is formed may then be modified by second fluorine-containing organic film (paragraph 16) that is modified (densified) by adding a gas such as Argon to the plasma (paragraphs 20-21 and 58-59). Thus, it would have been obvious to one of ordinary skill in the art at the time of invention to even separate the film forming and the modifying with the CO, Ar, N₂, and O₂ (paragraph 38) of Tsai into two steps, by adding that teaching of Jiwari to the invention of Tsai. The motivation to do so is that the process provides the predictable results of densifying the film, thus providing for good adhesion to underlying films (paragraph 11).

Re claim 2, Tsai and Jiwari disclose the limitations of claim 1, as discussed above, but Tsai does not further disclose that said modifying step is conducted so as to remove F atoms terminating an exposed surface of said F-doped carbon film. Jiwari discloses that said modifying step is conducted so as to remove F atoms terminating (paragraphs 11 and 60 and Fig. 4) an exposed surface of said F-doped carbon film. It would have been obvious to one of ordinary skill in the art at the time of invention to even separate the film forming and the modifying with the CO, Ar, N₂, and O₂ (paragraph 38) of Tsai into two steps, by adding that teaching of Jiwari to the invention of Tsai. The motivation to do so is that the process provides the predictable results of densifying the film, thus providing for good adhesion to underlying films (paragraph 11).

Re claim 3, Tsai further discloses that said modifying step is conducted in radicals containing any of N, Ar (paragraph 38), Kr, C, B and Si.

Re claim 6, Tsai further discloses that said source gas includes any of C₃F₄, C₄F₆ (paragraph 38) and C₅F₈ (paragraph 38).

Re claim 7, Tsai further discloses that said source gas is free from a hydrogen gas component (paragraph 38, wherein hydrogen is not included in any of the CF, CO, Ar, N₂, or O₂ gases).

Re claim 8, Tsai further discloses that said F-doped carbon film is formed by a plasma CVD process (paragraph 14) that uses the source gas containing C and F.

Re claim 18, Tsai further discloses that said nitrogen radicals are formed from a mixed gas of Ar and nitrogen (paragraph 38).

4. Claims 4, 5, and 9 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tsai and Jiwari, as applied to claims 1 and 8, above, and further in view of US 2002/0046808 A1 ("Hongo").

Re claims 4 and 5, Tsai and Jiwari disclose the limitations of claim 1, as discussed above, but do not further disclose that said radicals are excited by a microwave plasma (as pertains to claim 4), and that said microwave plasma is formed by introducing a microwave into a processing space in which said F-doped carbon film is formed by a planar microwave antenna via a microwave window that forms said processing space (as pertains to claim 5).

Hongo discloses exciting a microwave plasma (paragraph 15), and that said microwave plasma is formed by introducing a microwave into a processing space (S, Fig. 1) in which a film is formed (on wafer W, see paragraph 7 and Fig. 1) by a planar microwave antenna 76 (paragraph 61 and Fig. 1) via a microwave window (paragraphs 17 and 63) that forms said processing space.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to add the invention of Hongo to the invention of Tsai and Jiwari. The motivation to do so is that the combination produces the predictable results of forming the plasma using microwave frequencies in a low vacuum (paragraph 4) with improved planar uniformity of the plasma (paragraph 10) to assist in chemical vapor deposition (paragraph 36).

Re claim 9, Tsai and Jiwari disclose the limitations of claim 8, as discussed above, but do not further disclose that said plasma CVD process is conducted by dissociating said source gas by a microwave plasma.

Hongo discloses a plasma CVD process (paragraph 36) is conducted by dissociating a source gas by a microwave plasma (paragraphs 15 and 16).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to add the invention of Hongo to the invention of Tsai and Jiwari. The motivation to do so is that the combination produces the predictable results of forming the plasma using microwave frequencies in a low vacuum (paragraph 4) with improved planar uniformity of the plasma (paragraph 10) to assist in chemical vapor deposition (paragraph 36).

5. Claim 12 is rejected under 35 U.S.C. 103(a) as being unpatentable over Yoshitaka, as applied to claim 10, above, and further in view of US 2003/0084587 A1 ("Kumar").

Re claim 12, Yoshitaka discloses the limitations of claim 10, as discussed above, and further discloses that said step of depositing said F-doped carbon film further comprises a step of forming a hard mask film **108** (Fig. 2D) on a surface of said F-doped carbon film.

Yoshitaka does not further disclose that said step of depositing said F-doped carbon film and said step of forming said hard mask film are conducted respectively in first and second processing chambers coupled to a first vacuum transfer chamber, and said step of forming said opening and said step modifying step being are conducted respectively in third and fourth processing chambers coupled to a second vacuum transfer chamber.

Kumar discloses an apparatus **10** (Fig. 1) consisting of a substrate transfer chamber **16** and first through fourth processing chambers **18**, **20**, **22**, and **24** (Fig. 1). Kumar teaches performing each process of the process flow in a different chamber, for instance, etching a via **104** in the first chamber, forming an adhesion layer **106** in the second chamber, forming a barrier layer **108** on the sidewalls in the third chamber, and depositing the plug **110** in the fourth chamber (paragraphs 34-37). It would have been obvious to one of ordinary skill in the art at the time of invention to add the invention of Kumar to the invention of Yoshitaka, to thus perform the recited steps of Yoshitaka in the different recited chambers of Kumar. The motivation to do so is that the chambers are coupled to each other and separated from the environment, and thus allow for the processing to be performed without contaminating the film by the ambient environment (paragraphs 31-32).

6. Claims 14 and 15 are rejected under 35 U.S.C. 103(a) as being unpatentable over US 2003/0116854 A1 ("Ito") in view of US 5,989,998 A ("Sugahara").

Re claim 14, Ito discloses a method of fabricating a semiconductor device, comprising the steps of:

- depositing a fluorine-doped carbon film **14** (paragraph 48 and Fig. 9) on a substrate **24** (paragraph 48 and Fig. 9);
- forming an opening (area filled by 26 and 19, which is said in paragraph 88 to be formed by the same processes as in previous embodiments, so the opening is analogous to that described in paragraph 81) in said fluorine-doped carbon film by a dry etching process (RIE, reactive ion etching, is a dry etching process, paragraph 81); and
- depositing a first metal film **19/23** (paragraphs 82, 88, and Fig. 9; both 23 and 19 are said to be formed of Al) so as to cover a sidewall surface and a bottom surface of said opening,
- wherein there is provided, after said step of forming said opening but before said step of depositing said first metal film, a step of depositing a second metal film (paragraph 82, wherein an Al film is deposited) that forms a stable compound when reacted with F (Aluminum is said to be such a film, see the applicant's specification in paragraphs 127 and 129 of published application), such that said second metal film covers at least said sidewall surface and bottom surface of said opening (Fig. 9).

Ito does not disclose that the fluorine-doped carbon film is formed by a plasma CVD process that uses a source gas that contains C and F in a molecule thereof. Sugahara discloses that a fluorine-doped carbon film ("fluorinated amorphous carbon film", column 4, lines 26-27) is formed by a plasma CVD process (column 7, line 36) that uses a source gas that contains C and F in a molecule thereof (C_4F_6 , see at least chemical formulas 3 and 4, in column 14; and column 13, line 66 – column 14, line 38). It would have been obvious to one of ordinary skill in the art at the time the invention was made to add the invention of Sugahara to the invention of Ito. The motivation to do so is that the combination produces the predictable results of forming a fluorine-doped carbon film through a plasma process that results in a highly-crosslinked film that has an increased glass transition temperature and improved heat resistance (column 4, lines 28-39).

Re claim 15, Ito further discloses that said second metal film is selected from a group consisting of Al, Ru, Ni, Co, Pt, Au and Ag (paragraph 82, wherein Al is formed, and then oxidized).

Response to Arguments

7. Applicant's arguments with respect to claims 1-12, 14-15, and 18-19 have been considered but are either not persuasive, or are moot in view of the new ground(s) of rejection.
8. The rejections to claims 14-15 are maintained. The applicants argue (paragraph spanning pages 13-14) that the film 14 is from a "first embodiment" and that the Al film

is from a "third embodiment" that occur under "different conditions". This is unpersuasive. As noted in the rejection, the discussed elements are all shown in Fig. 9, which as discussed by paragraph 39 is the "third embodiment". While it is not explicitly discussed in the text, layer 14 is indeed shown in Fig. 9. Since it is not discussed to be formed of any different material, it would have been obvious to one of ordinary skill in the art to form it using the teachings of paragraph 48.

9. Regarding claims 1-13, claims 1 and 10 have been amended to require "nitrogen radicals", so all of these claims have changed scopes. Claims 18-19 are new. All of these new or amended claims require new rejections.

Conclusion

10. Applicant's amendment changed the scope of the claims and necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of

the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

11. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Kevin Parendo, whose can be contacted by phone at (571) 270-5030 or directly by fax at (571) 270-6030. The examiner can normally be reached on Mon.-Thurs. and alternate Fridays from 7 a.m. - 4:30 p.m. EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Matthew Smith, can be reached on (571) 272-1907. The fax number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Kevin A. Parendo/
Examiner, Art Unit 2823
12/12/2009

/Hsien-ming Lee/
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